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Report to the
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# VIRUS DISEASES OF FRUIT TREES AND DEVELOPMENT OF INDEXING TECHNIQUES FOR VIRUS DETECTION AND QUARANTINE

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME, 1962

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# REPORT TO THE GOVERNMENT OF ISRAEL

on

# VIRUS DISEASES OF FRUIT TREES AND DEVELOPMENT OF INDEXING TECHNIQUES FOR VIRUS DETECTION AND QUARANTINE

By

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Rome, 1962

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CONTENTS


Page

INTRODUCTION . . . . . 1

FRUIT CULTIVATION AND METHODS OF PLANT INTRODUCTIONS IN ISRAEL 3

PRESENT STATUS OF VIRUS AND OTHER DISEASES OF FRUITS . . . . . 5

ORCHARD SURVEYS . . . . . 5
APPLE FRUIT SURVEY . . . . . 8
VINEYARD SURVEY . . . . . 8
FRUIT TREE NURSERY SURVEYS . . . . . 9
OTHER CROPS . . . . . 9

ORGANIZATION OF POST-ENTRY QUARANTINE . . . . . 11

BASIS OF A GOOD BUDWOOD PROGRAM . . . . . 11
STANDARDIZED PROCEDURES GOVERNING PLANT INTRODUCTION . . 11
GENERAL GUIDE FOR OPERATIONS . . . . . 12
LOCATION AND ARRANGEMENTS FOR POST-ENTRY TESTS . . . . . 13
OTHER REQUIREMENTS . . . . . 14

ACCOMPLISHMENTS . . . . . 15

APPENDIX A . . . . . 18

APPENDIX B . . . . . 22

# INTRODUCTION

In accordance with the request of the Government of Israel for technical assistance in plant quarantine for the purpose of preventing the introduction of virus diseases of fruit trees, the Food and Agriculture Organization of the United Nations appointed, under its Expanded Technical Assistance Program, Dr. Earle C. Blodgett to advise and assist the Government in the development of techniques and facilities for detecting virus diseases of fruit trees and related activities, with particular reference to post-entry quarantine. The expert served in Israel from 20 September 1960 to 16 August 1961.

During the early period of his assignment, the expert spent most of his time in surveys of orchards, vineyards and nurseries, and on special problems. Most of the fruit areas were visited for the purpose of getting a general idea of the varieties, type of culture and the major problems present. The development of techniques was done on a demonstration basis and in some cases with introduced indicator plants. Training of personnel was accomplished through the experts' supervision of all operations and activities connected with orchard examinations, and indexing and care of plants.

The expert was stationed in the Ministry of Agriculture, Department of Plant Protection, in Jaffa. Close liaison was maintained with personnel in other Departments of the Ministry and with research and extension workers. Wide contacts were also established with owners and operators of orchards in order to obtain adequate information.

During his assignment, the expert was aided in many helpful and courteous ways by a great number of people. His deep appreciation and sincere thanks are due particularly to H.E. General Moshe Dayan, Minister of Agriculture and his associates, including Dr. A. Amir, Deputy Director General of Agriculture; Mr. Ben David, Assistant Director General; Mrs. L.N. Roman, Director, Technical Assistance Department; Mr. Gideon Cohen, Director, Plant Protection Department; Mr. S. Pappo, Head, Section of Plant Pathology; Dr. S. Spiegel, Director, Deciduous Fruit Tree and Vine Department; Dr. A. Grünberg, Head, Division of Pest and Disease Control; Mr. Israel Garmi, Nursery Service and his assistants; Dr. Z. Rappaport, Director, Horticulture Department; Mr. A. Rubenstein, Head, Quarantine Section; Mr. D. Barah, Senior Pomological Specialist; and Mr. Simha Ziv, Grape Specialist.

Acknowledgement is herewith made also for assistance received from Mr. Amiad, Director of the Extension Service and his associates, Dr. Y. Arnon, Director of the Research Station and his associates, members of the Fruit Growers Association, and the superintendents and other personnel of the stations at Acre, Kefar Hananya and Tsarafin.

The very close co-operation, professional help and personal courtesies of Mr. Pappo, who served as the expert's counterpart, are especially appreciated. Miss Zipora Fleisher, whom the Plant Protection Department designated to continue the project, is highly commended for her hard work and active interest in the program.

## FRUIT CULTIVATION AND METHODS OF PLANT INTRODUCTIONS IN ISRAEL

Almond, apple, apricot, fig, grape, peach and plum trees have been cultivated in a preliminary way for centuries in the area that is now Israel. The modern, commercial cultivation of these trees, however, is a very recent development, mainly since 1948. People from many parts of the world have made Israel their new home and brought with them desires for various kinds of fruit as they once knew it. Consequently they have imported special varieties from everywhere. In addition, during the early stage of the commercial orchard development, a large number of rooted nursery trees, understocks and scionwood of hundreds of varieties were introduced and distributed with little thought and knowledge of disease and insect problems. There was little control over these early importations and as this freedom of action is still partly present, undesirable plant introductions are continuously being made. There is good evidence that harmful virus diseases have recently come to Israel in this manner. Probably in no other country has this situation created so acute a problem. Up to the present only visual inspection, often under adverse conditions, has been required for release of new introductions and such introductions have been made under irregular and questionable conditions. Plant materials sometimes were secured without knowledge of the proper authorities and often the shipments originated from "dangerous" areas. Those who are closely associated with the fruit industry were sometimes guilty of unwise and illegal introductions. A careful consideration of the problem reveals the need now for an effective quarantine program.

At the present time there is no organized research in Israel on virus and virus-like diseases of the principal fruit crops; consequently there is little information available, even as to identity and occurrence of those diseases. There were of course suspected virus diseases, one of the most common being a shot holing of leaves of stone fruit trees, often accompanied by leaf mottle and bronzing, poor tree performance and sometimes death of the trees.

Over much of the country where the fruit trees are grown, high lime content of the soil requires the use of resistant rootstocks and other considerations. The almond is quite tolerant and is widely used, even under peach. There are many cases of so-called incompatibility in which the trees remain dwarfed or actually die early. In these cases, as well as in similar ones in cherry, apple, prune, pear and quince, it was difficult to determine whether a virus might be part of the complicated factors. The culture of apples and pears under semitropical conditions, often alongside citrus and bananas, causes change in fruit size and shape and tree growth, and these abnormalities are difficult to assess without index tests or host range studies that would take more than a year to complete.

At present fruit prices are high, especially apples and pears. This naturally leads to less attention being given to size, condition and appearance of the fruit. There are many types of skin defects and

abnormalities that go unnoticed, partly because all the fruit can be marketed. Pruning is one of the essential orchard operations that is sadly neglected, resulting in serious problems.

Part of the difficulties arise from the lack of adequate facilities and personnel trained in the field of post-entry quarantine, including techniques for indexing. The failure to recognize and support the legal obligation and to help provide facilities for an adequate program is a basis for ineffective work. There has been considerable, and apparently still is some, confusion and differences in understanding among the agencies involved in plant introduction. There is marked improvement, however.

## PRESENT STATUS OF VIRUS AND OTHER DISEASES OF FRUITS

In order to determine the virus diseases and virus-like disorders present in Israel, surveys of orchards, vineyards and fruit nurseries were initiated shortly after the arrival of the expert, and were continued throughout the year. The crops which received major attention during the surveys included the following:

Almond (*Amygdalus* spp.)
Apricot (*Armeniaca* spp.)
Apple (*Malus* spp.)
Avocado (*Persea americana*)
Cherry (*Prunus avium*, *P. cerasus*)
Grape (*Vitis vinifera*)
Loquat (*Eriobotrya japonica*)
Nectarine (*Prunus* sp.)
Peach (*Prunus persica*)
Pear (*Pyrus communis*)
Prune and plum (*Prunus* spp.)
Quince (*Cydonia oblonga*)

Before the surveys, four virus diseases of fruit trees were recognized: fig mosaic, asteroid spot of peach, sun blotch of avocado, and a bumpy fruit, leaf mottle disease of quince.

### ORCHARD SURVEYS

During the orchard surveys budwood samples for propagation of any leaf or fruit abnormality that appeared to be caused by virus infection or of genetic origin were collected and given accession numbers under the host. Indexing was carried out mainly for the ring spot virus in stone fruits and for the stem pitting virus in apples. *Prunus tomentosa* was used as the indicator plant in tests with stone fruits. The percentage of ring spot virus infection in stone fruits was determined, but it was only approximate because of the small number of samples used. The apple tests were less conclusive but interesting results were obtained.

In Table 1 are given the virus diseases and similar disorders recognized during the surveys, including those identified by indexing or by symptoms and suspected ones observed. The results of the orchard surveys, together with those of nursery surveys, have given a fair idea of the distribution of virus diseases and diseases with virus-like symptoms in Israel.

Table 1. Virus diseases and diseases with virus-like symptoms recognized during the orchard surveys.

| Crop | Virus diseases identified by indexing or symptoms | Suspected virus or genetic disorders | Accession numbers |
|---|---|---|---|
| Almond | Ring spot(16, 45%)* | Bud failure | Al 1-2 |
| Apple | Bumpy fruit of Ben Davis<br>Stem pitting | Rubbery wood<br>Flat limb<br>False sting or green crinkle<br>Rosette (nutritional ?)<br>Chat fruit | Ap 1-34 |
| Apricot | Ring spot(16, 80%) | Mottle, Ring pox | A 1-9 |
| Avocado | Sun blotch | Genetic troubles | |
| Cherry | Ring spot(13, 50%)<br>Sour cherry yellows<br>Crinkle of sour and sweet cherries<br>Deep suture | Leaf roll<br>Green ring mottle<br>Virus induced incompatibility | C 1-11 |
| Grape | Leaf roll<br>Yellow mosaic<br>Vein banding | Fan leaf<br>Genetic troubles<br>Several unknown | G 1-77 |
| Peach | Ring spot(37, 30%)<br>Peach necrotic spot | Yellows type Metulla disease<br>Witch's broom - Erez<br>Golden net<br>Peach mottle<br>Willow twig | P 1-16 |
| Pear | Vein yellows<br>Red mottle | Stony pit or similar deformed fruit<br>Angular leaf blotch<br>Decline<br>Variegation | |
| Prune | Ring spot(28, 47%) | Crinkle<br>Greasy spot<br>Shot hole<br>Decline<br>Several unknown | Pr 1-8 |
| Quince | Bumpy fruit and Mottle leaf | Stem pitting<br>Rough bark<br>Yellows<br>Aerial galls | Q 1-20 |

* Approximate amount of ring spot infection as determined by indexing with Prunus tomentosa as the indicator.

In the autumn and early spring tests involved over 300 plants; 2 apple seedlings were chip-budded with 2 buds from each of the several suspected apple selections, and above these buds was set one of the 4 crabapple or the Russian seedlings. Of the varieties tested, the Hashabi AP-1 and AP-10, Souccari AP-2, and Italian Doucin AP-3 gave a reaction indicating the presence of a mild strain of stem pitting or another virus. The odd leaf pattern and fruit deformity of Ben Davis was shown to be transmissible since characteristic leaf patterns were produced on the index bud and on the seedling shoots.

In the spring tests, indicator buds of the crabapple or the Golden Delicious were placed on the trunks of apple nursery trees of 12 varieties and layers of 12 rootstock selections, with an equal number of seedlings being used as checks. Although many plants in the plots, particularly Grand Alexander, did not become established and some of the indicator buds did not grow, there was evidence that a virus was present in the following clones: Black Jonathan, EMIX (old), Souccari, Hashabi and Italian Doucin. Results of the last 3 selections substantiate the autumn and spring tests. The presence of a peculiar yellow pattern (regarded by horticulturists as due to nutrition and temperature effects on the indicator crabs) was confined to the inoculated plants in the test. The amount of tree growth was materially reduced also. This reaction was not typical of stem pitting. Consequently another virus might be present in these rootstocks and its identity must await more indexing. The yellowing might be due to incompatibility. Tests with healthy Golden Delicious, at time of reading (10 August 1961) were negative in regard to rubbery wood virus.

Using Montmorency cherry buds, on the mahaleb seedlings above the inoculation, transmission was obtained with Moutakawi A-4 and Kadur 10 apricots, Meadow lark peach and Greek almond.

An interesting test was made with Bing and Montmorency cherry above the buds set in early autumn of 4 varieties of cherry from Italy. Half the 10 trees of each was indexed. One selection was positive and also showed obvious leaf pattern much like cherry crinkle and seep suture. Two others produced die-back of Montmorency and another was apparently clean but should undergo other tests.

Several hundred peach seedlings of Beladi and Rio Oso Gem were used as indicators in tests with cultures included in the "tomentosa index". No conclusions could be drawn from this test at the time when the expert left Israel. Using Bing and Montmorency cherry buds on mahaleb seedlings and above the inoculum buds of 13 selections, good symptoms were noted with cultures 11, 12, 90, 96 used in the tomentosa test.

It should be pointed out that many of these tests were primarily for the purpose of demonstrating techniques even though the conditions were not ideal.

Disorders of unknown causes. During the surveys of orchards, vineyards and nurseries there were many types of unknown troubles observed.

Some of these were tentatively designated with a name and given an accession number. A complete list and description of these disorders of unknown causes is on file in the Plant Protection Department. A summary is given in Appendix A of this report.

APPLE FRUIT SURVEY

Examination of 42 samples of apples grown in 1960 and 1961 revealed some interesting conditions. The disorder known as stem cavity russet occurred very early in the season and seemed to be most severe on short-stemmed fruit. In many cases the fruit was extremely flat and sometimes very small even in normal crops. In the Golden Delicious fruit a peculiar indentation, often near the calyx end, was observed in many orchards. Underneath was green-coloured tissue. This condition existed but was less obvious in older fruit. Symptoms were similar to that produced by codlong moth injury, and in fact entomologists suggested that this was the cause.

VINEYARD SURVEY

During the expert's stay in Israel, various problems concerning grape diseases were repeatedly brought to his attention. As time permitted he, together with members of the Plant Protection Department and growers, examined many vineyards. A total of 77 collections was made for diagnosis.

It is recognized that many factors may be responsible for decline in grapevines, and in their diagnosis, leaf symptoms, fruit symptoms, plant performance and longevity should all be taken into consideration. Somewhat detailed information on the observations and findings was maintained, but only a summary will be given here.

In order to determine whether viruses were involved in some of the disorders, a rather extensive indexing program was started. The vine with the best appearance was selected from each of the many variety plantings and this was used as a check or G-H number. Buds from the suspected vines were chip-budded to cuttings of healthy checks and the cuttings were then stored for rooting. In addition, 200 cuttings of dormant wood were imported from California and used as healthy indicators. Machine grafts were made, using the healthy Mission or Rupestris St. George on canes of the suspect. Over 1,000 cuttings were rooted in plots at Kefar Hananya and the percentage of rooting was high, except for sections of the rows that dried out from lack of water.

The grafts were reasonably successful, but the dormant chip buds were failures. At the time of reading, 10 August 1961, no evidence of transmission was noted but it was considered too early. Check plants were maintained for increasing the clone of indicators, but all the local G-H numbers were discontinued since they were not known to be free of virus.

Observations throughout the season, October 1960 to 2 August 1961, may be summarized as follows: (1) a fine leaf mottle found early in the season tended to disappear later, but it was common on many varieties which did not perform well. In one nursery it was prevalent on 41-B, but later was replaced by an angular leaf spot. (2) The Black Manuka and several other varieties showed a vein banding. (3) The foliage of Black Rose was very poorly developed and several cases of green ring patterns, angular spots and leaf burning were observed. (4) The leaves of Alphonse at Kiftah were deformed and mottled and then became necrotic and fell early. (5) Mosaic-like symptoms were found on Tamar and Sultan. (6) Failure of fruit to ripen or colour properly was a common complaint of the growers. (7) The leaf roll symptoms were widespread in plantings from far north to the south. Some affected plants died during the winter.

Although proof is not available, there was good indication that yellow mosaic, leaf roll and vein clearing were present and prevalent in some plantings. Odd vine growth was observed and mixed stocks were found in the rootstock plantings at Plugot. Considering the importance of the grape industry and the presence of infectious diseases, it seems appropriate to initiate an extensive indexing program and to arrange for well-controlled imports if new clean material is requested. Research is urgently needed also.

FRUIT TREE NURSERY SURVEYS

Only limited observations were made in the tree fruit nurseries but several interesting discoveries were made. During inspection of the cherry nursery stock it was found that all the Black Tartarian trees showed symptoms of crinkle leaf and deep suture, the two virus-like diseases often associated. The mother trees also showed symptoms. In fact, no healthy trees of this variety were seen in the nurseries or orchards of Israel. Since fruiting of affected trees is very poor, often less than 30% of a normal crop, the variety is worthless there.

In some nurseries peach necrotic spot was prevalent in certain varieties and could be readily observed.

It was obvious that many stool beds of apples and quince contained mixtures of one or more types. This is a serious matter, although it is often considered lightly. There were also too many variety mixtures, especially in pears, as observed in the surveys. Some of the nurseries did not do good work in insect or pest control, in maintaining stock true to name, and in general, cultural practices.

OTHER CROPS

Although several field trips were made at various times of the year with regard to citrus diseases, no specific work was done other than observations. This was true also with some other crops. It was known that fig mosaic was very prevalent, probably close to 100% infection.

An interesting die back, leaf scorch, decline and death of olive trees in the Rosh Pinna area was observed. There seemed to be no ready explanation for the condition. Young date palms near Yotvota were having trouble characterized by root injury. The trees of walnut, pecan and macadamia nuts were examined for witch's broom disease, but none was observed.

Examination of strawberries was very restricted and a virus disease was often the limiting factor in its culture.

Virus diseases in carnations, bulb crops and gladiolus were frequently observed, and in "seed" stocks they were serious factors in production. Fusarium disease in gladiolus was a limiting factor in the Hulch plantings.

## ORGANIZATION OF POST-ENTRY QUARANTINE

The profitable cultivation of many important crops throughout the world has at one time or another been, or still is, seriously jeopardized by one or more virus diseases. The dissemination of tree fruit viruses in clonal understocks, in scions, and sometimes by seeds, is of great concern to serious-minded agricultural people, because in most countries many of the important pests and diseases have come from abroad. The devastating effect of some virus disease outbreaks has been the cause for sober thought and for a resolve to support basic principles of plant quarantine.

## BASIS OF A GOOD BUDWOOD PROGRAM

The importation of the best material obtainable, the proper indexing of all selections, and the maintenance of all clean varieties under proper isolation and sanitation will ensure the supply of good foundation scion wood and understocks for the orchards of Israel. While the facilities are not yet available, the pro ects seem good that a reasonably satisfactory post-entry program will be implemented. Attention has been directed to the necessity, wherever accurate and useful results are desired, for all experiments in varietal testing to be conducted only with clean, healthy and true-to-name material, on known, clean understocks. Experiments with infected material result only in a waste of time and effort.

A somewhat parallel situation exists in the orchards where only the best of stock for planting should be used, in view of the lack of space, the high cost of water and care, and the long-term investment. Poor stock is often worse than none.

## STANDARDIZED PROCEDURES GOVERNING PLANT INTRODUCTION

In order to prevent the invasion of dangerous pests and diseases, particularly diseases of virus origin, arrangements were made to develop a satisfactory quarantine program, involving mainly a prior permit system and adequate indexing of introduced material. The procedures suggested may be summarized as follows:

No plant material is to be introduced into Israel except under official permit duly issued by the Plant Protection Department. In granting the permits, the Department should give due regard to all available information, experience and technical advice, which may be furnished by a small, representative committee. The request for a permit must be accompanied by specific information, including the name and address of the person making the request, the kind and variety and nature of the plant material, its intended use and the name and address of the person who will furnish the material.

The shipment should be addressed to the Department of Plant Protection, Quarantine Division. Upon receipt it will be carefully examined and may be accepted and treated, or rejected and destroyed. If it is acceptable, the material will be submitted promptly to the Plant Pathology Section for indexing on suitable indicator plants for virus detection. This procedure may require one to three years, and, except for well-known material, all shipments should go through all standard tests.

If the index tests are satisfactorily completed, the selection can be released to the Horticultural Department for test purposes. One to three plants will be maintained in the screenhouse and in the plot for clean material - the repository. The Plant Pathology Section should have complete control of the release of the foundation stock both in the screenhouse and in the repository and will be responsible for repeated indexing of the mother trees.

Varieties, seed stocks and clonal stocks of local origin should be tested where there is a possibility of obtaining clean trees. Propagation of virus-infected varieties should not be permitted if clean material can be secured.

For the avocado industry it seems desirable to secure healthy material on which can be based a budwood and seed source indexing program. It will require a long time, but can be started in a small, effective way. Since sunblotch is the only known virus disease of this crop and since increase of the disease is only through infected budwood or by seed transmission, good progress can be made. Removal of diseased trees is dependent on economic conditions, but no infected stock should be permitted in scion or seed tree areas.

For the stone fruit crops, indexing is desirable for all local seed and scion source trees used in the propagation of plants.

GENERAL GUIDE FOR OPERATIONS

1. The Plant Protection Department is legally the agency for all plant introductions.

2. Plant material entering Israel without a proper permit should be promptly destroyed.

3. All plant material to be permitted entry should undergo the index tests and requirements of post-entry quarantine.

4. One person should be in charge of conducting the index tests and be responsible for discarding unacceptable material and for release of clean material.

5. All introduced plant material should be propagated on congenial and clean seedling understock (except for layered plants or cuttings).

6. The clinic is primarily a function of the Plant Protection Department, but budwood of all desirable selections should become available for research. The clinic must be well cared for, on good soil, and kept free of complicating factors.

7. Strictly accurate and complete records of all plant introductions are essential. The value of complete and accurate details related to the origin and history of plant introductions cannot be over-emphasized. The judgment involved in decisions as to the value and use of imported plant material is dependent on where the stock originated and by whom it was sent. The name of the country, the state or the county is not enough. The exact tree code number and name of sender are desired and all similar data should be part of the record available at any time.

8. The collection of disease-free varieties on suitable stocks is regarded as of very high priority in order to provide foundation material for indexing, research and nurseries. The growing location should be isolated, preferably in a suitable screenhouse and where reasonably good growing and fruiting conditions prevail. It is believed that over the years this phase of the project, if done properly, will be the highlight of fruit production in Israel.

9. As the Plant Protection Department has the responsibility of protecting the agricultural resources of the nation, with every available legitimate means, against the menace caused by the introduction of pest and disease factors, any hindrance or even passive resistance to its efforts is a grave mistake in judgment.

10. Post-entry quarantine is an important and serious governmental obligation and requires the undivided support of all agencies and individuals.

LOCATION AND ARRANGEMENTS FOR POST-ENTRY TESTS

For the tests used in post-entry quarantine, the expert makes the following suggestions with regard particularly to their locations and the size of plots.

1. Index tests using Prunus tomentosa or herbaceous plants, and similar tests are to be done in a suitable screenhouse at Jaffa.

2. Introductions are to be taken to Kefar Hananya and placed in a screenhouse for this purpose only. The indexing should be done in plots located at this Station.

3. Clean selections are to be housed (two to three plants each) in the new screenhouse, and two to three additional plants kept in an "isolated" repository at Kefar Hananya. If a better location can be arranged later, a change may be made.

4. It seems highly desirable to establish a central or main quarantine station. For the tree fruits, Kefar Hananya seems to be an acceptable location. There are advantages in keeping as much of the work as possible in one place.

5. The present plan involves pome fruits, stone fruits, avocado, grape, strawberry, nuts and similar crop plants, but not citrus. In some cases, indexing procedures must be worked out. In all types of plants suitable understocks or provisions for increasing cuttings must be available when needed.

6. Plot locations. Index plot and plots for longer term tests, for growing index plants and for repository should all be located at Kefar Hananya. Plots for repository should be as much isolated as feasible. Clinic plots should be located at Acre.

7. Screenhouses. Clean budwood screenhouse - Kefar Hananya; this was nearing completion. Introduction screenhouse - Kefar Hananya; this should be built in 1961/62. Screenhouse or greenhouse at Jaffa; some temperature control is essential and should be available for use by February, 1962.

OTHER REQUIREMENTS

In order to store and preserve seeds and plant material it is essential that a suitable, ample-sized cold storage unit with temperature and humidity control be provided. This does not need to be excessively expensive if properly designed and operated.

Until local supply of seed and seedlings becomes available, it will be necessary to import enough stock with necessary safeguards.

A research program on tree fruit diseases is urgently needed. The work should be done by competent plant pathologists with properly equipped facilities. The research requirements should be properly co-ordinated with those of plant quarantine. Mutual support and confidence is the main key to a successful program.

Since the quarantine station and the test plots are far from Tel Aviv, adequate transportation becomes one of the more important items. Good results cannot be expected if the test plots cannot be frequently visited and properly cared for. Good care must be taken of plants and details must be supervised. Therefore, it seems appropriate to recommend that if the present budget does not allow suitable means of travel, the Fruit Growers' Association should provide it.

Progress towards an effective, smooth-working quarantine program requires the genuine interest and co-operation of all involved.

## ACCOMPLISHMENTS

In addition to the surveys and post-entry quarantine arrangements already described, the expert, during his assignment, carried out some activities which would be useful to the future work on fruit viruses in Israel. It should be mentioned, however, that any progress achieved in this connection was the result of the close co-operation between the expert and his Israeli colleagues.

1. Introduction of New Techniques and Materials

a. Indexing techniques for detection of fruit tree viruses - The Shirofugen flowering cherry is one of the most effective indicator plants for the ring spot virus of stone fruits. However, this variety is not available in Israel, and since it carries a serious virus disease its introduction was not recommended. Instead, arrangements were made to use Prunus tomentosa and it served very well. The essential features of the pome fruit indexing, as far as they have been developed, were demonstrated. Attention was also directed to the need for detection of virus diseases masked in some plants. The methods for this were demonstrated, and many of the indicator plants were secured and increased. Other herbaceous plants, such as cucumbers and squash, might be used as indicators under good greenhouse conditions.

b. The clinic - The establishment of a clinic for the diagnosis of unknown diseases of fruit trees was one of the most useful and valuable aids in virus and nursery work. It has been primarily used by the Plant Protection Department, and also as emergency aid for decisions in plant introduction. It is mainly for virus and virus-like diseases. The materials received are recorded with accession numbers and the culture is usually kept after identification. It is essential that all selections of one kind be grown on the same rootstock. For example, it is most undesirable to grow some peach selections on almond and others on peach or apricot. A single type of rootstock will eliminate the confusing aspect of incompatibility.

c. Orchard mapping - One of the most useful methods to follow the development of plant diseases, particularly those caused by viruses, is to prepare a good map of an orchard or part of one. Usually the size, condition or appearance of each tree is recorded from year to year on a map. If anything changes or new infections occur they can readily be determined. This technique was introduced and demonstrated by mapping over 600 quince trees in one orchard, noting the vigour of the trees, the number lost in 1960 from a sudden decline, and the number showing stem pitting on the trunk.

d. Collection of leaf and plant specimens - A good specimen collection with accurate records is a valuable asset. It may serve as a guide on the distribution of certain troubles or as an aid in identification. Great care must be used to prepare and label properly specimens of leaves, twigs and fruit.

c. Introduction and maintenance of clean budwood - One of the essential features of indexing is the use of clean budwood of the indicator. For this purpose a number of varieties were introduced. The names of these introduced varieties and the virus diseases to be detected by them are listed in Appendix B to this report.

The use of an insect-proof screenhouse is essential for keeping clean budwood. At the proposal of the expert, a new screenhouse, measuring 6 x 16 metres and 2½ metres high, was built at Kefar Hananya. It is covered with a brass screen of 32 mesh, which would keep out most insects, but a good protective spray program should be maintained as well.

2. Investigation of Fruit Diseases

a. Determination of an apple virus disease - A single tree of Ben Davis apple bearing bumpy fruit was brought to the attention of the expert. Closer examination showed that a leaf deformity was associated. Inoculum buds from this tree were placed, in November 1960, on seedlings below one of the buds of a red leaf crab. Growth in the spring showed similar symptoms on the crab leaves and also on shoots from the apple seedling. This is the first known virus disease on apples in Israel. Two bearing trees in the original orchard were also bud inoculated.

b. Yellows type disease of peach - The cause of a peculiar yellows disease in two commercial orchards and several home orchards near Metulla was investigated. Ten healthy trees were inoculated in August 1961 to test transmission.

c. Apple tree decline - The presence of a widespread condition in young apple orchards was of considerable interest. A root rot effect, beginning principally from the smaller roots and producing finally a stub end root, was present in many orchards. The bark from the roots of sick trees was transferred by bark patches to roots of healthy appearing trees. Several trees were inoculated. Whilst there was no specific evidence of the presence of a virus, it seemed desirable to start preliminary tests.

3. Assistance in Potato Inspection

At the invitation of Mr. Rubenstein of the Plant Quarantine Section, the expert accompanied Mr. Rosen to the Port of Tel Aviv in February 1961. Several hundred tons of seed potatoes from North Europe were on the dock for inspection. The unloading conditions and inspection

facilities were entirely unsatisfactory and prompted suggestions for improvement. Plans for a small, well-lighted sorting table were secured and with this equipment a reasonable inspection would be possible. Mechanical damage to tubers, both in unloading and inspection, was excessive and these might easily be reduced. A report was prepared for the Ministry of Agriculture.

Upon the invitation of Mrs. Zimmerman-Gries of the Research Station, Beit Dagon, the expert assisted in potato examination on two occasions during sorting at the plant located at Beriruim. Some of the sorting equipment was satisfactory, but certain tables caused heavy mechanical damage. Suggestions were made to eliminate the undesirable effects. From the early spring examination a small plan was developed to study some of the potato skin defects.

4. Technical Discussions and Training

During his assignment, the expert gave a lecture on indexing techniques currently used in the U.S.A. before the Horticultural Seminar Group at Beit Dagon and also a lecture summarizing his work during the year before a large group. In addition, he participated in a number of technical and planning meetings, including one on avocado sunblotch disease.

Miss Zipora Fleisher, a member of the Plant Protection Department, was assigned to work with the expert and to acquire training in the techniques of indexing and post-entry quarantine. Under general guidance, she was capable of operating a post-entry quarantine program.

## APPENDIX A

### Disorders of unknown origin observed in Israel

Almond

1. Rosette, bushy growth on Victoria.

2. Witch's broom on almond rootstock under Amsden peach.

3. Leaf necrotic spotting and shot holing.

4. Necrotic spots on fruit and cankers on twigs that might be due to Coryneum beijerenckii.

5. Sudden death of many bearing trees in an orchard near Ramle in the spring of 1961. The trouble was thought by some to be due to severe drought and late watering the year before.

Apple

1. Chlorotic leaf spotting, vein clearing and a rusty mottle condition rather widely distributed in Hashabi rootstock beds. The early growth was not affected but it was common in the autumn. This disorder had not been seen on other rootstocks nor varieties, but was noted on Hashabi suckers.

2. A marbled, yellow leaf condition on terminal growth of Merton Malling 102.

3. A bronze leaf condition in the terminals of East Malling XV.

4. Rough, aerial galls and what appear to be root or stem primordia on the Hashabi specimen trees at Kefar Hananya and on Grand Alexander at Ein Shemer.

5. Scaly or rough bark conditions on red and golden delicious trees in several orchards. More severe measles type was noted in 2 or 3 orchards, mostly on Delicious.

6. Weak, weepy-type growth suggestive of rubbery wood on a few nursery apple trees.

7. A flat limb type condition common on the Orleans variety.

8. A false sting type condition particularly in Golden Delicious suggestive of Green Crinkle.

9. So-called "Rosette", quite common. It may be due to nutrition, growing conditions or to other reasons. There was a tendency to regard it as zinc deficiency.

10. Some trees bear large, near normal size fruit, and also very small, flat fruit. This is suggestive of chat fruit, or possibly proliferation.

11. Tree decline in many orchards, causing vigorous trees to die in a comparatively short time. Many, but not all, cases were associated with Hashabi roots. In any case, the roots appeared to die back from the tips and upon removal of affected trees there was evidence of root dieback and dead areas in the bark.

12. An unknown necrotic leaf spot, widespread, in Ben Davis.

13. Stem cavity russet very common on all varieties except Rome and Gallia Beauty. The fruit often becomes rough and cracked and the disorder is a serious defect in grading.

Apricot

1. A mottle leaf condition, common in Moustakawi and Aloui varieties generally.

2. Trunk canker and gummosis on Aloui in one orchard.

3. Necrotic fruit spot and pox-like marks on fruits in many orchards in varying amounts. In some respects it resembles ring pox.

Avocado

1. Leaf deformities suggestive of genetic abnormalities, on a small percentage of seedlings used as rootstock.

Cherry

1. A leaf roll and cupping suggestive of leaf roll virus disease on some trees of Red Esperen.

2. Green ring mottle disease might be present in the Hortense variety. This is not certain until proper indexing on Montmorency is completed.

3. Tree decline or sudden wilt and death of trees in several cherry orchards. There was no obvious cause, but observations on the bud union (Mahaleb rootstocks) tissue indicated the possibility of a virus induced incompatibility.

4. Injury from herbicide sprays to the soil, resulting in marginal chlorosis and necrosis.

Grape

1. Asteroid mosaic type symptoms in several plantings.

2. Leaf variegation occasionally observed.

3. Decline and death of vines in several plantings. Often the plants had red leaf symptoms the season before.

4. Chronic decline of rather common occurrence. The nodes were close together, foliage was small and yellowish, and fruiting was below normal.

5. The trouble on Perle de Csaba at Kibbutz Geva was of particular interest since the fruit withered early and the vines weakened and were removed.

6. The Alphonse at Yiftag showed severe necrotic spotting and leaf burn. Many leaves fell early and the fruit sunburned. This is a recurrent problem.

7. Stem pitting in various degrees was frequently observed.

8. What may be fan leaf, rosette and up-cupping of the leaves was noted in some varieties and in certain rootstock plants.

Peach

1. A peach yellows type disease on Elberta, Red Haven, Lovell and Kachamas at Metulla. Trees showed numerous weak and spindly shoots, small and yellowish leaves and excessive branching of shoots. Fruits ripened very early and often were misshapen. Spread in the orchard occurred and affected trees were worthless.

2. Witch's broom on Harold's Jubilee at Erez. The leaves were prominently spotted with small yellow areas.

3. Stem proliferation, leaf tip necrosis, and small malformed foliage in a planting near Acre. Similar symptoms were said to occur in plots at Beit Dagon and on nursery trees at Plugot.

4. What appears to be peach golden net in a few trees.

5. Mottle on leaves in a planting in Heletz.

6. Bark blister on Babcock peach twigs in three locations.

7. A weepy, corkscrew type growth on samples from Heletz.

8. Both nursery and orchard peach trees on almond rootstock frequently were affected by off colour and poor growth and might die, probably due to incompatibility.

9. Shot holing and necrotic spotting of foliage of fairly common occurrence, probably due to peach necrotic spot, sprays or dust injury or unknown cause.

10. A red suture condition on fruit from a home orchard.

11. A disorder similar to yellow leaf roll in Ein Hashlosha.

Pear

1. Decline of Pear on quince rootstock, due to, at least in some cases, incompatibility. There were also cases of decline and death of pears on pear root.

2. Variegation of both leaf and fruit.

3. The disorder known as angular leaf blotch on nursery and orchard trees, generally on Cascia and Spadona trees. It was usually associated with distinct twisting and down-curling of leaves.

4. Fruit deformity and pitting of Spadona somewhat similar to stony pit.

5. A peculiar black speckling of Spadona fruit widely observed, in many cases causing a grade defect.

6. A rough, cracked skin condition and an early breakdown of pear fruits from one orchard.

7. Scab (Venturia pyrina) infection on few fruits of Spadona pear. Mr. Pappo stated that this disease is common on local or wild pear but in ten years he had not seen it on cultivated varieties.

Prune

1. What was regarded as crinkle on Black Prince nursery stock.

2. A shot hole of Japanese plums, very common and often associated with other symptoms such as greasy spot, decline and marginal chlorosis.

3. Greasy spot as water soaked areas on leaves, often associated with shot hole and tree decline.

4. Decline of common occurrence in some orchards. Apparently healthy trees entered into a stage of poor growth, and might die. It might be due to incompatibility alone or a combination of factors.

5. A prominent flat limb condition on the Methley plum, often in spiral formation on the main lateral branches.

Quince

1. Stem pitting of rather widespread occurrence.

2. Rough bark in some trees at Mishmar Hasharon.

3. The rough aerial gall condition noted in apple was seen on Portugal quince in the nursery and also on two bearing trees. This was fairly common on the understock when quince was top-worked high.

4. Yellows, common in quince stool beds and in terminal growth of trees in many areas. A decline and death of quince trees was frequently accompanied by severe yellows.

## APPENDIX B

### List of introduced varieties for use as indicators

| Crop | Variety | Virus diseases to be detected |
|---|---|---|
| Almond | Non pariel | Mule ear |
| | | Almond calico |
| | | Almond bud failure |
| Apricot | Tilton | Ring pox |
| Prosser, Wash. | | Virus gummosis |
| Apple | Golden Delicious | Mosaic |
| Prosser, Wash. | | Rubbery wood |
| | | Russet Ring |
| | | Apple Proliferation |
| | | Star crack |
| | Purple Wave | Stem pitting |
| | Purple Lemoine | " " |
| | Jay Darling | " " |
| | Evelyn | Chlorotic leaf spot |
| | Russian Seedling | " " " |
| | Merton Malling 106 | " " " |
| Cherry | Bing | Mottle leaf |
| Prosser, Wash. | | Twisted leaf |
| | | Rusty mottle |
| | | Rugose mosaic |
| | | Rasp leaf |
| | | Asteroid spot |
| | | Little cherry or K and S |
| | | Albino |
| | | Almond mosaic |
| | Montmorency | Sour cherry yellow |
| | | Necrotic ring spot |
| | | Green ring yellows |
| | | Pink fruit |
| Grape | Mission | Leaf roll |
| Davis, California | | Fan leaf |
| | | Yellow mosaic |
| | | Vein banding |
| | | Asteroid mosaic |
| | Rupestris St. George | Fan leaf |
| | | Yellow mosaic |
| | | Vein banding |
| | | Asteroid mosaic |

| Crop | Variety | Virus diseases to be detected |
|---|---|---|
| Peach<br>Prosser, Wash. | Elberta | Yellows<br>Little peach<br>Peach rosette<br>Red suture<br>Rosette mosaic<br>Phony<br>Mosaic<br>X disease<br>Yellow bud mosaic<br>Asteroid spot<br>Golden net<br>Willow twig<br>Peach necrotic spot<br>Prune dwarf<br>Stubby twig<br>Almond bud failure<br>Mule ear<br>Peach wart<br>Peach mottle |
| Plum<br>Prosser, Wash. | Shiro | Line pattern<br>Almond calico<br>Plum white spot<br>Golden net |
| | Krihon | Prune dwarf |
| Pear<br>Kent, England | Bartlett | Red mottle virus<br>Vein yellow virus<br>Pear blister canker |
| Quince<br>Kent, England<br>This clone was lost in propagation | | Sooty ring spot<br>Stunt virus |
| Strawberry<br>Corvallis, Oregon | Fragaria vesca var. alpina | Latent viruses |